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ABSTRACT

Teacher questions have been the subject of a substantial amount of research and analysis in recent years. Debate has centered around the appropriate use of this instructional and evaluative tool. A study examined the impact on student achievement of manipulating abstractness-concreteness, independent of cognitive level, in achievement test items. Subjects for the study were 66 students enrolled in a senior-level class at a major university in the southwest United States. The specially constructed test was administered to students during the course of a regularly scheduled quiz period, and there was no suggestion to subjects that this quiz was any different than others they had taken. Results revealed that manipulating the cognitive complexity of test items influenced students' ability to respond correctly. The data suggest that these differences have important impact on student achievement. The difficulty students had with higher-than-recall items suggest the need to consider further the usefulness of cognitive level, and abstractness-concreteness in explaining student achievement. (JMK)

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The Effect on Student Achievement of Manipulating Abstractness-Concreteness Independent of Cognitive Level

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Teacher questions have been the subject of a substantial amount of research and analysis in recent years. Debate has centered around the appropriate use of this instructional and evaluative tool. The publication in 1956 of Bloom's Taxonomy of Educational Objectives: Handbook I - The Cognitive Domain had a particular import because it provided a framework for the classification in terms of cognitive complexity not just of educational objectives, but also of teacher questions.

The argument has been that student learning is enhanced when students ". . . are oriented at a higher taxonomic level" (Dunkin and Biddle, 1974; Kuen, Cohen and Loman, 1981). It has been demonstrated that most teacher questions are asked at lower cognitive levels (Sanders, 1966) and as educators set about to enhance students' higher order skills, the impact of that change on student achievement was studied. Results have been contradictory.

Rogers and Davis (1970) found no significant overall relationship between the teacher's use of higher cognitive questions and student achievement. The relationship which Ragosta (1971) found was negative. Thomas Andre (1979) showed that "higher level questions can have facilitative effects on both reproductive and productive knowledge . . . ." Winne (1979) wrote, after reviewing many studies, that teacher questioning behavior has no effect on student achievement. Interestingly, Redfield and Rousseau (1981) performed a meta analysis on the same data that Winne used and concluded that "teacher's predominant use of higher cognitive questions has

a positive effect on student achievement" and that "gains in achievement can be expected when higher cognitive questions assume a predominant role during classroom instruction" (p. 237).

Researchers have offered a number of potentially valid explanations of these inconsistent findings ranging from a general criticism of research techniques and methodology to more specific interpretations concentrating, for example, on the specific student of whom the question is asked (Andre, 1979). In the absence of any widely accepted interpretation of those results, an attempt at some alternative justification seems called for.

There exists a substantial body of research - much of it in essential agreement - regarding the impact on instruction of the concreteness or abstractness of instructional activities. An area with substantial theoretical promise is one suggested by Solomon (1970) who, when he noted that the highest levels of teacher cognition related positively with concrete classroom experiences and negatively with the abstract experiences (p. 59), indicated that there were <u>two</u> dimensions with which one ought to be concerned: cognitive level and abstractness. Joint consideration of the two dimensions has not been noted elsewhere and is, in fact, somewhat in contradiction to the original work on the taxonomy which suggested that knowledge objectives varied from concrete to abstract <u>in parallel</u> with variations from simple to complex (Dunkin and Biddle, p. 243). It seems that analyses of instructional activities have consistently (with the exception noted) ignored a two-dimension

explanation of student response to instructional activities. In an attempt to explore the possibilities that differences in concreteness and abstractness within a given cognitive level may affect learning, this study asks: What is the impact on student achievement, of manipulating abstractness-concreteness independent of cognitive level in achievement test items?

Method

Sample

The sample for the study consisted of 66 students in two sections of a senior level class entitled "Secondary School Curriculum," at a major university in the Southwest. The enrolled students represented a variety of majors outside of Educational Curriculum and Instruction. There was an approximate balance between males and females. In addition to the 66 student experimental group, 13 students in a junior level education course were used in an early phase of the study to categorize concepts along a concrete-to-abstract contiuum.

Materials

The development of appropriate test items required that concepts be classified as either abstract or concrete. Procedures for that classification are available. Gorman (1961) categorized 1061 nouns by using two judges and providing dictionary definitions of abstract and concrete. Spreen and Schulz (1966) used a Thorndike-Lorge procedure to scale 329 familiar nouns on a 7-point concreteness scale without reference to dictionary definitions.

For this study, a variation of those procedures using judges was employed. Prior to a regularly scheduled quiz, the instructor's notes and related text material were scanned for significant concepts relating directly to the course objectves. A list of 70 was extracted. This list was arranged in a Likert format with the concept followed by response options 1 through 5. A response option of 1 indicated that the respondent felt the concept was concrete, 2 indicated rather concrete, 3 indicated neutral, 4 indicated rather abstract and 5 indicated abstract.

The judges used for the classification of concepts were the 13 students in the junior level education course. Each copy of the instrument included directions which asked that respondents carefully consider the following information on abstractness and concreteness:

1. Concrete concepts have perceptible attributes; the attributes of the concept can be perceived through the senses - the words are more "picturable" (Mussen, Conger and Kagan, 1974);
2. Concrete words have greater meaning in isolation. They are words which are learned without the necessity of having learned otherwords (Russell, 1940 in Paivio, 1971);
3. Abstract terms derive their meaning largely through intraverbal experiences (Paivio, 1971);
4. Abstract concepts have attributes that cannot be directly perceived - cannot be "pointed to" (Gagne, 1974); and
5. Abstraction requires manipulation of spatially and temporally remote events (Paivio, 1971).

The judges responses were analyzed by the TESTAT (Veldman, 1967) computer procedure. The eight concepts judged to be most abstract (Mean responses from 4.00 to 4.72), and the

eight concepts judged to be most concrete (mean reponses from 1.15 to 1.92) were selected.

From these 16 concepts, 32 multiple choice items with four choices each were constructed, all with the particular concept as the subject in the stem. The structure of the instrument was as follows: item 1 used a concrete concept and was a recall item; item 2 used an abstract concept and was a recall item; item 3 used the same concept as item 1 but was at a cognitive level higher than recall; item 4 used the same concept as item 2 but was structured to be higher-than-recall; items 5 and 6 introduced new concrete and abstract items respectively and were structured similarly to items 1 and 2. This patterm was maintained throughout the instrument such that all odd numbered items used concepts judged to be concrete, and all even items used concepts judged to be abstract. Each concept was used twice; once as the subject of a recall item, once as the subject in a cognitively higher-than-recall item.

Procedure

All testing was conducted by this writer during the course of a regularly scheduled quiz period. There was no suggestion to subjects that this quiz would be any different from others they had taken. The 66 students took the instrument in two groups. The test was not timed. Each student was given as much time as he/she desired to complete the test.

TESTAT (Veldman) with subscale scoring was employed to analyze student response in terms of achievement on each of

the four groups of items as well as on individual items. In addition, a two-way ANOVA was conducted (SAS, 1979) to test for the statistical significance of the effect of the independent variables - cognitive complexity and abstractness - on the response variable - student test scores.

Results

The initial administration of the 70-concept scale to the "judges" yielded a mean score of 208.2 with a standard deviation of 21.9 and a reliability coefficient of .8278.

insert table 1 about here

Results of the administration of the 32 item instrument (see table 1) were as follows: Each subgroup included 8 items. The mean on group 1 (concrete concept, recall item) was 6.12. On group 2 (abstract concept, recall item) the mean was 5.64. On group 3 (concrete concept, higher-than-recall item) the mean was 3.83, and on group 4 (abstract concept, higher-than-recall item) the mean was 5.00.

Standard deviations were relatively more stable, ranging from 1.27 in group 1 to 1.33 in group 3. Reliabilities in the subgroups ranged from .0234 in group 3 to .36 in group 1.

insert table 2 about here

The two way ANOVA tested the impact of the two independent variables and the interaction of those variables on student achievement. The level of abstractness of the concept used in the test item was not found to be statistically significant. The cognitive complexity of the item and the interaction of the two main effects were found to be significantly different. Students had substantially more difficulty with questions which were higher-than-recall and concrete than they did with either type of recall question. They had slightly more difficulty with abstract questions which were higher-than-recall than with the recall questions.

Discussion

Data revealed that manipulating the cognitive complexity of test items influenced students' ability to respond correctly. This was particularly clear for concrete concepts appearing in higher-than-recall items and was borne out by the ANOVA. Significant differences in scores relating to the cognitive level ($f=219.55$; d.f.=1, 65) and the interaction of cognitive level and abstractness ($f=59.16$; d.f.=1, 65) appeared unlikely to result from random change factors. The data suggest these differences had important impact on student achievement. The pattern was less clear for test items where only the concept's abstractness was at issue. The ANOVA indicated that the abstractness of the concept alone was not a significant factor.

The difficulty students had with the higher-than-recall, concrete items suggests the need for closer examination - particularly since Solomon's work (indicating the positive re-

lationship between high cognitive level and concreteness of the classroom experience) suggests the opposite effect. Careful scrutiny may reveal that instructors have a tendency, when asking higher order questions, to use abstract concepts almost exclusively. This seems particularly likely if the assumption is made that movement from the concrete to the abstract parallels the movement from cognitively simple to cognitively complex.

Table 1 indicates that reliability figures for the subgroups were low. In the case of subgroup 3, which is particularly low, the reason may be involved with the explanation of the unusual difficulty students experienced with the subgroup. In any case, it is worthy of note that those figures become .694, .665, .087 and .536 for groups 1 through 4 respectively if the Spearman-Brown procedure is used to step the subgroups up to 32 items each.

The validity of these findings relies in part on the expectation that students have had experience during lecture sessions with each of the four types of items - that the greater difficulty encountered on items from subgroup 3, for example, was not just a manifestation of confusion over a new type of item. An attempt to pursue this lime of research would require some control for that element, particularly in light of work by Brophy and Evertson (1976) and Stallings and Kaskowitz (1974) which suggests a positive relationship between the frequency with which questions are asked in the

classroom, and student learning.

Though the group which was asked to make the initial judgment about the abstractness or concreteness of a particular concept was comparatively small (13), the substantial reliability (.83) yielded suggested that there was reason for confidence in those judges' responses.

A fundamental assumption underlying this and much other work employing Bloom's Taxonomy is that it is a cumulative hierarchy and, as Kunen (1981) has pointed out, empirical validation of that assumption is absent (see also Furst, 1981; Phillips and Kelly, 1975). That clearly poses an important obstacle in the research should the assumption not be validated. There was an attempt to avoid the problem here by employing a dichotomy of recall, and beyond recall.

The effort in this study has been to approach the relationship between student achievement and the structure of the test item. When this relationship is analyzed only in terms of the cognitive level of the question or test item, the results are inconsistent. The present study adds a second dimension - abstractness. The significance of the results suggests the need to further consider the usefulness of these two dimensions in explaining student achievement. Explanatory efforts which utilize only one dimension may be misleading. Further work ought to ask whether achievement among students of various ability groups bears a relationship to these two dimensions. Also of interest is the relationship between achievement and the type of item that students most

commonly encounter. Fundamentally, replication of this study opens the possibility for a more informative look at questioning and achievement testing.

TABLE 1

Mean Scores, Standard Deviations and Reliabilities
on the Subgroups and the Entire Test

subgroup	n	#items	$\bar{x}$	s	r
1. concrete concept, recall item	66	8	6.1364	1.2660	.3618
2. abstract concept, recall item	66	8	5.6364	1.2984	.3318
3. concrete concept, higher-than-recall item	66	8	3.8333	1.3374	.0234
4. abstract concept, higher-than-recall item	66	8	5.0000	1.3143	.2242
5. the test as a whole	66	32	20.6060	3.1952	.4843

TABLE 2

Analysis of Variance of Cognitive Complexity, Abstractness and the Interaction

source	df	ss	F	PR > F
cognitive complexity	1	167.0455	219.55	.0001
abstractness	1	.9697	1.52	.2224
Cog * Abst.	1	37.8788	59.16	.0001

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